THE RELATIONSHIP BETWEEN BASALTIC CLASTS IN MESOSIDERITES AND THE HED METEORITES: CLUES FROM MN-CR SYSTEMATICS OF TWO VACA MUERTA CLASTS.

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Mesosiderites are brecciated stony-iron meteorites that are composed of almost equal proportions of silicate clast materials and Fe-Ni metal. The origin of the silicate clasts within these meteorites has been a topic of much debate, especially with regard to whether or not these silicates are genetically related to achondritic meteorites of the HED association [1,2,3,4]. We report here the Mn-Cr systematics of two clasts from the Vaca Muerta mesosiderite. Our goal was to (1) further refine the available chronological information and (2) obtain constraints on the relationship between these clasts and the HED meteorites. The two clasts studied here, i.e., Vaca Muerta Pebble 16 (VM16) and clast 4679 (VM4679), are composed mainly of pyroxene and plagioclase and have been classified as "monogenic basalts" by [4]; petrographic characteristics have been described in [4,5].

We have measured $^{53}Cr/^{52}Cr$ ratios and Mn and Cr abundances in chromites (Chr) and bulk silicates (Sil) in each of these two basaltic clasts. Since Vaca Muerta has a long exposure age (~133 Ma [6]), small spallation corrections to the measured $^{53}Cr/^{52}Cr$ ratio of 6 and 8 ppm were required for the VM16 and VM4679 bulk silicate fractions, respectively; the spallation contribution in the chromite fractions is negligible. The results of our analyses are shown in the Figure, which presents a plot of the $^{53}Cr/^{52}Cr$ ratios, expressed in ε-units (i.e., excesses in ^{53}Cr, relative to the terrestrial value, in parts per 10^4) versus the $^{55}Mn/^{52}Cr$ ratios. Within the precision of the analyses (i.e., 6-13 ppm), both clasts appear to have equilibrated isotopic composition and, therefore, only upper limits for the inferred $^{53}Mn/^{55}Mn$ ratios are given in the Figure. The magnitude of the ^{53}Cr excesses are much higher than found in chondrites (~0.5 ε) [7] and are similar to those found in eucrites [8]. The Cr isotopic compositions of chromite and bulk silicates from VM4679 are the same within 1 ppm (1.08 ± 0.07 and 1.09 ± 0.08 ε, respectively), and ^{53}Mn was clearly extinct at the time of the last Cr isotopic equilibration. In contrast, the $^{53}Cr/^{52}Cr$ ratio in chromite from VM16 may be slightly lower (0.97 ± 0.06 ε) than that in bulk silicate (1.10 ± 0.13 ε). If the apparent slope defined by the data is real, then ^{53}Mn could have been extant ($^{53}Mn/^{55}Mn \sim 3 \times 10^{-7}$) in VM16 at the time of its isotopic closure. However, the Sm-Nd data clearly show significant disturbance at a relatively late time [9] when ^{53}Mn was no longer alive. Thus, it is more likely that the Mn-Cr system was also equilibrated at this time, albeit not completely. The same argument holds true for VM4679, although the Cr isotopic equilibration is complete in this case.

We have calculated from mass balance constraints, but not yet measured, $^{53}Cr/^{52}Cr$ and Mn/Cr ratios in bulk rocks (TR) of each of the two Vaca Muerta clasts. The values estimated for $^{53}Cr/^{52}Cr$ are 1.01 ± 0.13 and 1.09 ± 0.08 ε-units, while those for the $^{55}Mn/^{52}Cr$ ratios are 1.95 ± 0.10 and 2.11 ± 0.21 for VM16 and VM4679, respectively (shown in the Figure as open symbols). The HED "bulk meteorite isochron" determined by [8] is also shown in the Figure. As is apparent, the calculated bulk rock data points for VM16 and VM4679 fall, within 2σ errors, on this isochron. This implies either (1) that *at least* these clasts originate from the HED parent body, (2) that, more broadly, mesosiderites and HED meteorites come from the same parent body, or (3) that the mantles of the mesosiderite and HED parent bodies differentiated at precisely the same time, i.e. 4565 ± 1 Ma ago [8]. Possibility (3) appears to be the least likely whereas (1) may be safe to conclude. However, it is premature, although intriguing, to accept possibility (2) at this time.

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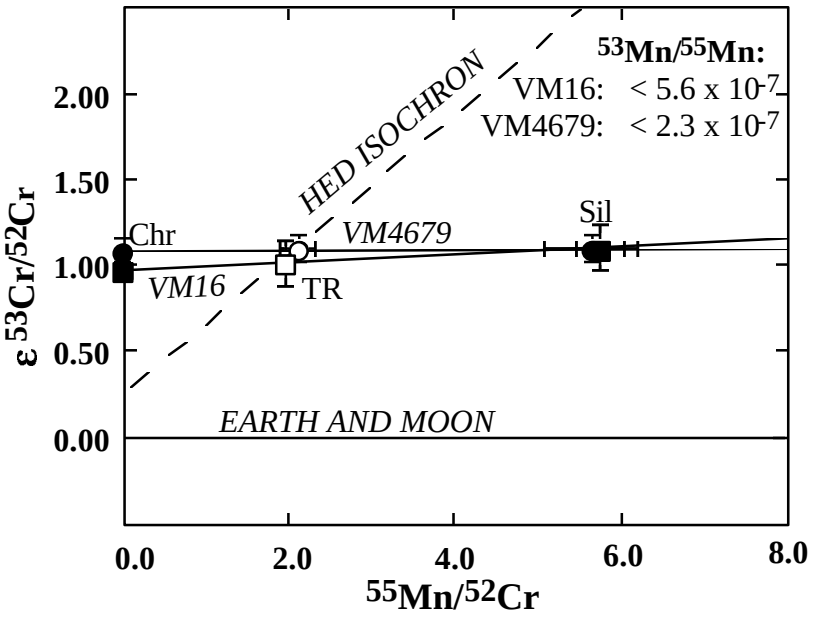

Figure: ^{53}Mn-^{53}Cr isotope systematics of two Vaca Muerta clasts, Pebble 16 (VM16; solid squares) and clast 4679 (VM4679; solid circles). The excesses in ^{53}Cr are expressed in ε-units, i.e., excesses in ^{53}Cr, relative to the terrestrial value, in parts per 10^4. Upper limits on the ^{53}Mn/^{55}Mn ratios are $< 5.6 \times 10^{-7}$ and $< 2.3 \times 10^{-7}$ for VM16 and VM4679, respectively. The dashed line is the HED bulk meteorite isochron determined by [8]. The open symbols (indicated as TR) are bulk rocks calculated, from mass balance constraints, for each clast. Note that these calculated bulk rocks fall on the HED isochron.